A RAND NOTE

A Calculus of First-Strike Stability (A Criterion for Evaluating Strategic Forces)

Glenn A. Kent, Randall J. DeValk, David E. Thaler

June 1988

40 Years 1948-1988

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PREFACE

This Note, prepared as part of the Project AIR FORCE National Security Strategies Program, describes an approach for evaluating the first-strike stability (or instability) of various postures of superpower strategic offensive forces. The study is intended to assist senior Air Force leaders as they continue to assess the merits of alternative U.S. and Soviet strategic force postures.

SUMMARY

For analyzing the merits of alternative strategic nuclear force postures, first-strike stability offers a more relevant and demanding criterion than deterrence, as commonly defined. First-strike stability exists if neither superpower perceives the other as motivated to strike first in a crisis. First-strike instability arises when either nation perceives the other as pressured or tempted to strike first in a crisis.

In the context of deterrence, as generally understood, when a national leader considers whether or not to launch a first strike, he believes that by not striking, he can avoid strategic nuclear war. He might be tempted to strike first if he believed that such an attack would achieve some national security goal(s) and, at the same time, reduce the adversary's retaliatory capability sufficiently that his retaliation would not cause unacceptable damage. In the narrowest sense of deterrence, if the adversary's retaliatory strike would cause unacceptable damage, the leader would be deterred from striking first and strategic nuclear war would be avoided.

The calculus of first-strike stability, in contrast to that of the narrowest sense of deterrence, involves a calculus of the cost of striking first compared with the potential cost of waiting and risking an enemy first strike. In the context of first-strike stability, a leader facing a crisis might perceive that the consequence of waiting would be an enemy first strike rather than the avoidance of strategic nuclear war. **The new ingredient in this context is the pressure to strike first so as to avoid the worse consequence of striking second.**

Two conditions, operating together, might generate pressure to strike first: (1) the perception by the leader of Country A of the likelihood that Country B will launch a first strike if he waits and (2) the extent to which the expected cost to Country A associated with going second would exceed its cost of going first. Country B would simultaneously weigh these two factors.

The quantitative analysis of force postures should focus on determining the cost to each side of striking first compared with that of striking second. This Note presents such an analysis. If the force postures can be shown to be stable, the chance of escalation due to uncertainties regarding the enemy's intentions and likely responses diminishes.

According to the analysis, the current postures of U.S. and Soviet strategic offensive forces do not demonstrate any undue degree of first-strike instability. While there may be a difference in the cost to either country between going first and suffering an enemy first strike, this difference is not pronounced enough to warrant serious concern. Neither country possesses the capability to significantly limit damage by striking first. Devastation would result whether one struck first or second.

An examination of worst-case notional changes in current force postures demonstrates that, in modernizing their strategic offensive forces, the United States and the Soviet Union have the potential to significantly erode first-strike stability. Although the current postures are relatively stable, changes in the ability to target strategic nuclear forces could create an alarming degree of first-strike instability.

To enhance the survivability of its strategic offensive forces and help prevent the erosion of first-strike stability, the United States has the following broad options:

- **Increasing the survivability of its intercontinental ballistic missile (ICBM) force** through mobility, redundant silos, terminal interceptors, or some combination of these.
- **Placing a larger proportion of existing bomber and ballistic missile submarine forces on day-to-day alert.**
- **Imposing sustained and comprehensive constraints—through arms control—on U.S. and Soviet weapons, particularly ballistic missile reentry vehicles, and ballistic missile throwweight.**
- **Making credible the option to launch U.S. ICBMs before Soviet warheads can destroy them in their silos.**

Finally, this analysis illustrates that merely reducing the level of U.S. and Soviet offensive forces does little to enhance stability and may actually increase first-strike instability. The types and posture of forces deployed have a much greater effect on stability than their numbers. That is, an arms control agreement mandating large reductions might erode stability if one or both sides were to preferentially retain many ICBMs carrying multiple independently targetable reentry vehicles deployed in a relatively few fixed aim points. **To maintain stability, reductions in offensive weapons should be coupled with improved basing modes.**

ACKNOWLEDGMENTS

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I. INTRODUCTION

> Stability should be the primary objective both of the modernization of our strategic forces and of our arms control proposals.
>
> —*Report of the President's Commission on Strategic Forces*, April 1983

The subject of stability arises in virtually every discussion of U.S. national security and/or arms control. Most allusions to stability in the current debate on national security issues imply *first-strike stability* (or instability)—the extent to which either superpower perceives the other as motivated to strike first in a crisis.

RELATIONSHIP OF FIRST-STRIKE STABILITY TO DETERRENCE

The concepts of first-strike stability and deterrence are related, but they differ in context. Deterrence, as commonly understood, implies the threat of a retaliatory nuclear strike that would cause unacceptable damage to a potential aggressor and therefore would deter him from striking first. In this context, when a national leader considers whether or not to launch a first strike, he believes that he has the choice of either striking first or waiting, that is, avoiding strategic nuclear war. In making this decision, he considers the gains (damage to the enemy's assets) and risks (potential damage to his own assets) associated with launching a first strike.[1]

In the narrowest calculus of deterrence, if a rational leader concludes that the adversary's retaliation would cause unacceptable damage to his own assets, he is deterred and strategic nuclear war is avoided. In a more general formulation, a leader might be *tempted* to strike first if he concluded that such an attack would achieve some significant national security goal(s) while reducing the opponent's forces to a point at which retaliation

[1]A first strike is defined for this purpose as an attack with strategic nuclear weapons by Country A on Country B's strategic nuclear forces, i.e., the forces capable of striking, first or second, Country A's homeland. Country A's first strike also may include an attack against value targets—i.e., theater projection forces, leadership, and vital urban-industrial targets—in Country B. A first strike may arise out of an ongoing localized conflict in which vital superpower interests are threatened—whether or not nuclear weapons have been used.

would cause only minimal damage. This construct of deterrence has dominated analyses of the merits of various U.S. and Soviet strategic offensive force postures.

First-strike stability also involves a decision about whether to launch a first strike against the adversary or to wait. In a deepening crisis, however, neither leader would be certain as to the consequences of waiting: Would he avoid strategic nuclear war or, conversely, would he risk an enemy first strike against his country? The new ingredient in this context is the *pressure* to strike first in order to avoid the much worse alternative of incurring an enemy first strike.

For the purpose of analyzing the merits of alternative force postures, first-strike stability, in our view, offers a more relevant and demanding criterion than the narrower concept of deterrence outlined above. First-strike stability rests on a different calculus, namely, the cost of striking first compared with the potential cost associated with waiting and possibly incurring an enemy first strike. Accordingly, analysis of the relative stability of alternative force postures should focus on determining these costs for each side.[2]

These costs depend on the damage that a nation would suffer minus the damage that it would inflict on the enemy in any exchange. Of course, the damage to the enemy is discounted by some factor because the value of saving one's own assets (especially population) far exceeds the value of destroying the adversary's assets, i.e., the objective of limiting damage always outweighs the objective of inflicting damage.

CONDITIONS OF FIRST-STRIKE STABILITY AND INSTABILITY

The concept of first-strike stability would apply to two different crisis environments: (1) a deepening crisis in which neither superpower had yet used nuclear weapons and (2) a deep crisis in which either superpower had made limited use of nuclear weapons. Either of these crisis environments might aggravate the conditions that could generate pressure on a leader to launch a massive first strike.

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[2]Extended deterrence—using the possibility of an attack by U.S. central strategic forces to help deter Soviet political coercion or military aggression against U.S. allies in Europe—depends in part on an element of first-strike instability. Extended deterrence and first-strike stability imply quite different force postures. The former dictates a U.S. force posture that convinces the Soviets of U.S. resolve to strike first in the event deterrence of military action fails. The posture should inject into the Soviet calculus a degree of uncertainty as to the possibility of unintended escalation. To enhance extended deterrence, for example, the United States might emphasize counterforce capability while accepting vulnerable basing modes. Such a posture could, however, promote first-strike instability in a crisis. Accordingly, as regards force posture, an inherent tension exists between extended deterrence and first-strike stability.

Two conditions, operating together, might in a crisis create pressure to strike first: (1) the perception by the leader of Country A of the likelihood that Country B will launch a first strike if he waits and (2) the extent to which the expected (potential) cost to Country A associated with going second exceeds its cost of going first. Country B would simultaneously weigh these two factors.

Temptation would increase the pressure to strike first. If the leader of Country A perceived that Country B was tempted to strike first, he would feel pressured to strike first to avoid the worse consequence of going second. The leader of Country B would then feel pressured to strike first so as to exploit the opportunity while it still existed. Under these circumstances, first-strike instability could arise in a crisis when either country perceived the other as being tempted to strike first.

Finally, threats to vital interests might produce pressure to strike first. During a crisis, the leader of Country A might believe that Country B would strike first to preserve such interests, even though that strike might result in high retaliatory damage. This belief could create pressure on the leader of Country A to preempt. If the leader of Country B believed that the leader of Country A held this perception, pressure to strike first would feed itself.

First-strike instability would become acute in a crisis if each country perceived the other as possessing the capability to significantly limit damage by striking first, i.e., the capability to destroy the other's forces to the extent that a retaliatory attack could almost be tolerated. Said another way, if each country believed that it lacked a secure and credible second-strike capability and perceived that the other country held the same belief about itself, serious first-strike instability would exist.

If, in contrast, both sides possessed highly survivable strategic offensive forces and if strategic defensive forces were not really effective, large numbers of U.S. and Soviet weapons could survive the other's first strike and penetrate to enemy targets in retaliation. In this case, there would be little or no pressure to strike first because neither side could significantly limit damage to itself if it struck first.

The instability that might arise from a leader's uncertainties with regard to the enemy's intentions and likely responses must remain subjective. If, however, the force postures can be shown through quantitative analysis to be stable, i.e., if, for each side, the cost of striking first would not be substantially less than the potential cost associated with waiting and possibly incurring an enemy first strike, the chance of escalation in a crisis due to such uncertainties diminishes.

STABILITY AND THE CONDUCT OF LEADERS IN CRISIS

One cannot quantify the degree to which uncertainties that a leader would face in a crisis would affect his perceptions of first-strike stability or instability. Such uncertainties could, however, significantly constrain his actions as he pursued national security objectives.

If, for instance, Soviet strategic forces were so vulnerable that only a few of their weapons could be expected to survive a U.S. first strike, a U.S. president might perceive the Soviets as pressured to preempt in a deepening crisis. Under these circumstances, the president might conclude that he must exercise extreme caution in pursuing initiatives in other arenas so as not to further aggravate the situation. Uncertainties regarding Soviet responses when facing force postures with an undue degree of first-strike instability could thus limit the president's freedom to act in areas not directly related to strategic nuclear forces. The Soviets would face the same uncertainties and thus perhaps the same limitations.

The quality of a country's command and control of its strategic offensive forces also might affect a leader's conduct in a crisis. He might perceive uncertainties about command and control as eroding stability. For instance, he might fear that the adversary was tempted to launch a decapitating first strike because such a strike could blunt the effectiveness of a retaliatory blow. Accordingly, more robust command and control could serve to improve first-strike stability.

The uncertainties influencing a leader's perception of first-strike stability or instability might thus significantly affect his conduct in a crisis. However, relatively stable force postures minimize such uncertainties and thus contribute to stable crisis management.

OVERVIEW OF THE STUDY

In this Note, we demonstrate the calculus of first-strike stability as a criterion for judging the merits of alternative U.S. and Soviet strategic nuclear force postures. In so doing, we hope to clear up two misconceptions.

First, some observers believe (in our view, incorrectly) that the current posture of U.S. and Soviet strategic forces lacks first-strike stability. These observers often try to justify this assertion with the argument that a Soviet first strike could virtually destroy the U.S. ICBM force, thereby rendering the United States unable to effectively target a specified Soviet target base in its retaliatory attack—a target base, incidentally, defined by U.S. analysts.

A second popular misconception is the belief that large reductions in strategic offensive forces are themselves inherently stabilizing. Rather, as we will show, without the appropriate measures to increase force survivability, reductions may erode first-strike stability.

We do not intend to suggest that a superpower crisis would necessarily lead to a U.S.-Soviet nuclear exchange. We seek simply to highlight the U.S. and Soviet force postures that, at the margin, make what is now an extremely unlikely course of action by either superpower seem less unlikely.

Section II of this Note proposes an overall approach to assessing the stability or instability of alternative strategic force postures and, in particular, those postures resulting from possible arms control measures. We then use this approach to examine how and why some postures reinforce first-strike stability while others erode it. Section III summarizes the policy implications of this examination. Appendix A presents the U.S. and Soviet strategic force postures, and Appendix B describes the attack scenarios and assumptions on which the analysis is based.

II. DEMONSTRATING FIRST-STRIKE STABILITY (OR INSTABILITY)

As noted in the preceding section, first-strike stability depends on each side's calculus of the cost of striking first compared with the potential cost associated with waiting and possibly incurring a first strike by the other side. We assume that if a country actually struck first, the central objectives of the attack would be to limit damage to itself and, at the same time, to inflict damage on the adversary.

To limit damage to himself, an aggressor would launch a counterforce attack, i.e., he would strike the enemy's intercontinental ballistic missiles (ICBMs), sea-launched ballistic missiles (SLBMs), bombers, and perhaps the command and control apparatus in the hope of denying execution (or at least efficient execution) of a retaliatory attack. To inflict damage on the adversary, an attacker would strike the enemy's value targets, such as theater projection forces (with the intention of denying the adversary his war aims), leadership, and perhaps portions of the urban-industrial base that the attacker perceived would inhibit the victim's post-strike recovery.

To demonstrate relative first-strike stability emanating from force posture, we develop here a format that allows us to graphically depict U.S. and Soviet attack options for a given posture of strategic offensive forces. By examining these attack-option curves, we can demonstrate the degree of stability or instability.

STANDARD WEAPONS AS A METRIC

For purposes of the analysis, we measure the potential destructive capacity of U.S. and Soviet strategic offensive forces in terms of *standard weapons* (SWs).

Underlying the SW concept is the notion that ballistic missile reentry vehicles (RVs) do not all possess equivalent potential destructive capacity; real qualitative differences exist between various types of RVs on U.S. and Soviet ICBMs and SLBMs.

The standard weapon metric assumes that, for a first-order approximation, the throwweight associated with a ballistic missile RV can serve as a proxy for the greater destructive potential of the larger weapons on some ballistic missiles, e.g., the Soviet SS-18. For bombers, take-off gross weight and the equipment (or lack of it) to carry long-range, air-launched cruise missiles (ALCMs) determine the assigned SW value.[1]

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[1]The senior author has proposed the standard weapon as a metric for assessing the potential destructive capacity of missiles and bombers as follows: The number of SWs assigned to a particular missile is determined by the larger of two numbers: (1) the number

While no single measure can fully reflect the destructive potential of U.S. and Soviet ballistic missiles and bombers, the standard weapon provides an approximation superior to more conventional measures, such as megatons and equivalent megatons. When employed in our format, the SW can be used in measuring the price that each side must pay—i.e., the number of weapons that each side must expend—to attack individual elements of the other's strategic nuclear forces, including fixed-site ICBMs, SLBMs on nuclear-powered ballistic-missile submarines (SSBNs) in port, and bombers. One can then calculate and depict graphically the "exchange rate" for attacking these individual elements as well as the adversary's strategic forces as a whole.[2]

THE GRAPHIC FORMAT

Because it is designed to facilitate a coherent and, above all, an objective assessment of the relative stability of U.S. and Soviet force postures, the graphic format that we use to demonstrate relative first-strike stability or instability deals with weapons without translating weapons available to attack value targets into the currency of damage to these targets. The percentage of value targets damaged is not included for two reasons.

First, our guideline was to display only the information reasonably available to both nations' leaders. While Country A and Country B may have approximately the same perception of the quantity of weapons available to each to attack the value targets of the other side, they might make widely different assumptions as to the nature of each other's attacks against these targets. Thus, the two leaders are likely to have widely different

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of warheads the missile carries or (2) the throwweight of the missile in kilograms divided by 400 kilograms for missiles with multiple independently targetable reentry vehicles (MIRVs) and 500 kilograms for single-RV missiles. By these counting rules, a U.S. C-4 SLBM with eight RVs and 1400 kilograms of throwweight is charged eight SWs, while the Soviet SS-18, which is assumed to carry ten RVs and have 7600 kilograms of throwweight, counts as 19 SWs (7600/400). For bombers, the SW number depends on the size of the bomber and whether or not it has been equipped to carry modern cruise missiles. The SW number assigned to a strategic bomber is determined by the aircraft's take-off gross weight (in kilograms) divided by 11,350 kilograms for ALCM-equipped aircraft and 22,700 kilograms for aircraft without ALCMs. Roughly speaking, ALCM-equipped heavy strategic bombers are counted as 20 SWs—approximately the number they can potentially carry. Strategic bombers without cruise missiles are counted as eight to ten SWs—again, close to the number they are believed to carry. A detailed breakdown of the SW value assigned to each weapon in the 1986 U.S. and Soviet force structure may be found in Appendix A, Tables A.1 and A.2. See also Glenn A. Kent, *A New Approach to Arms Control*, The RAND Corporation, R-3140-FF/RC, June 1984.

[2]Other, more conventional measures, such as weapons or equivalent megatons, employed in this graphic format, would yield similar, albeit less precise, results.

perceptions as to the type and scope of damage the other's weapons might inflict on their own value targets.

Second, this format was designed to represent the interaction of strategic nuclear forces in clear and unambiguous terms. Measures of damage mask which forces are being attacked and destroyed and which forces are surviving. After analyzing strategic force interaction, the analyst can then offer his own perception of damage to each nation's value targets (not done in this study).

The absolute numbers of U.S. and Soviet SWs likely to survive the other's first strike reflect the potential to damage the value targets of the other side. When both sides have more secure and more robust retaliatory capability (i.e., high numbers of surviving SWs), the force postures involved are deemed to contribute to first-strike stability. First-strike instability might arise if one side could substantially limit damage to itself by striking first. First-strike instability would become acute if neither side could expect a large number of SWs to survive an enemy first strike. Thus, our format demonstrates relative stability by showing the number of SWs remaining to both sides after a first strike by either side.

In the upper left portion of this format, as displayed in Fig. 1, the United States has the potential to inflict much damage on Soviet value targets while the Soviet Union can do little to U.S. value targets. In the lower right, the Soviet Union has large potential destructive capacity and the United States, little. The 45-degree diagonal line consists of a locus of points where the United States and Soviet Union have approximately the same measure of destructive potential. Above this line, the United States has a simple (numerical) advantage over the Soviets; below the line, the Soviets have the numerical advantage.

The shaded bands along the x-axis (Soviet potential standard weapons on U.S. value targets) and y-axis (U.S. potential standard weapons on Soviet value targets) represent *notional* areas that should be avoided to prevent first-strike instability. A Soviet first strike resulting in a point lying within the shaded band along the x-axis would represent a posture of strategic forces with considerable instability.

A Soviet first strike could result in a point in the shaded band along the x-axis only if a large portion of U.S. ICBM, SLBM, and bomber weapons were vulnerable to attack. If a U.S. president indeed believed this state of affairs to be the case, he might consider a Soviet attack highly likely in a crisis. Under these circumstances, he might be pressured to launch a preemptive strike so as to avoid what he perceived as imminent Soviet exploitation of U.S. force vulnerability. The Soviets, in turn, might be pressured to strike first to exploit this situation while it existed—particularly if they believed that the United States was seriously considering a preemptive attack.

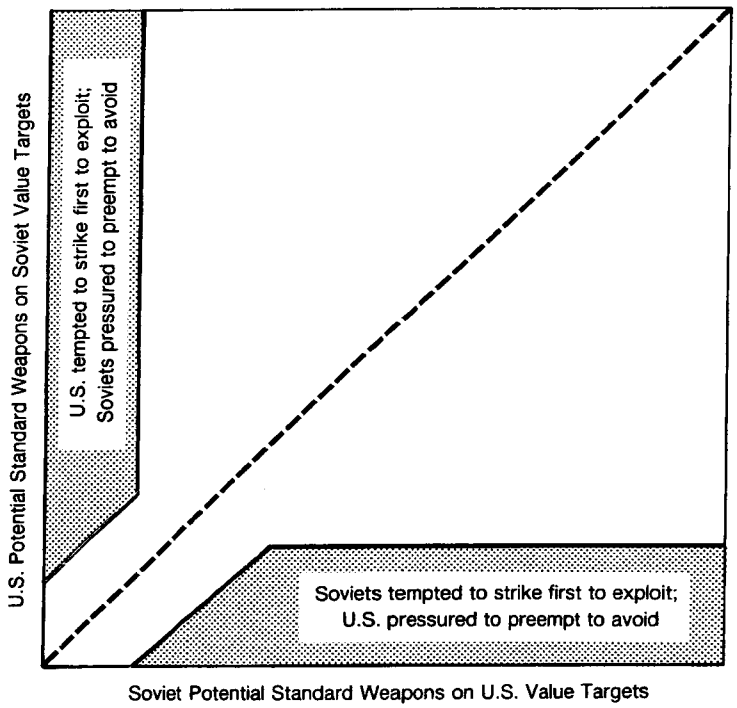

Fig. 1—Notional Areas of Pressure and Temptation to Strike First in a Crisis

In the shaded band along the y-axis, in contrast, the Soviet leaders might believe that the United States was tempted to attack vulnerable Soviet strategic offensive forces. Soviet leaders might thus be pressured to preempt so as to avoid this outcome.

The bands denoting areas where either superpower is motivated to strike first intersect the x- and y-axes at points to the right of and above the origin. The fact that the bands do not intersect the origin accords with our assumption that an attacker would have to be fairly confident that he could inflict a certain amount of damage on an opponent in his attack before he would consider attacking. In other words, we assume the existence of a "damage-inflicted" threshold below which neither side would have any motivation to attack.

Furthermore, we postulate a "damage-suffered" threshold, indicating that neither side would be tempted to attack when the damage incurred from a retaliatory attack could not be limited to below that level. The amount of retaliatory damage that each side would be willing to accept (represented by the number of surviving SWs) determines the widths of the bands in Fig. 1. The widths may vary: For instance, as shown in Fig. 1, the area of Soviet

temptation may be somewhat greater than the area of U.S. temptation, owing to a general assumption that the Soviet target base is larger than the U.S. target base.

As can be seen, the bands constitute a relatively small part of the regions to either side of the 45-degree line. These bands are relatively small in recognition of the fact that, given the tremendous destruction that the detonation of even a limited number of modern nuclear weapons would cause, a simple numerical edge (in delivery platforms, weapons, or potential SWs on the other's value targets) favoring either superpower is exceedingly difficult—if not impossible—to translate into operational superiority.

The bands that we have drawn are neither exact nor mathematically precise; the closer one moves toward either axis, however, the greater the degree of first-strike instability. The exact number of U.S. SWs that would be required to survive for potential retaliation against Soviet value targets to prevent the Soviet leadership from being tempted to strike first is a matter of Soviet perspective. We cannot know the number with any confidence; therefore, we do not designate a specific number on the x-axis to indicate where this region begins. The same lack of specificity applies to the location of the line parallel to the y-axis.

The judgments in this analysis on the relative first-strike stability or instability of U.S. and Soviet strategic offensive force postures are based on our belief that relative stability should be determined by examining the effects of each side's attack on the other's strategic forces as a whole, rather than by focusing on any single element. For example, although certain elements of the U.S. strategic nuclear force structure may be more vulnerable to attack than others, these forces can still contribute to first-strike stability by complicating Soviet attack plans and increasing the Soviet price to attack. In other words, the standard for assessing the merits of a given deployment should not center on the number of weapons of a particular force element that survive a Soviet attack concentrated on that force element.

BASE CASE: CURRENT U.S. AND SOVIET STRATEGIC OFFENSIVE FORCES

According to most analysts, rough parity exists between U.S. and Soviet strategic nuclear attack systems.[3] The standard weapon metric used in this analysis reflects this

[3]The U.S. and Soviet force figures used in this Note are based on the following sources: Department of Defense, *Soviet Military Power 1986*, U.S. Government Printing Office, March 1986; *United States Military Posture FY 1987*, Organization of the Joint Chiefs of Staff, 1986; International Institute for Strategic Studies, *The Military Balance 1985-86*, London, 1985; Congressional Budget Office, *Costs, Effects, and Alternatives*, November 1987; and *Jane's All the World's Aircraft*, Jane's Publishing Company Limited, London, 1986.

assessment. The Soviets have over 16,000 SWs; the United States has nearly 13,000 SWs.[4] Quantitatively (and qualitatively) superior U.S. SLBM and bomber forces largely offset the Soviets' marked advantage in ICBM RVs and ballistic missile throwweight. We use the graphic format illustrated in Fig. 1 (above) to assess the relative degree of first-strike instability inherent in current U.S. and Soviet strategic offensive force postures.

A closer look at the Soviet strategic nuclear force posture reveals that nearly 70 percent of the Soviet SW total is associated with ICBMs; the Soviets have placed only 20 percent of their strategic offensive forces on SSBNs and only 10 percent on bombers. The Soviet emphasis on land-based, fixed-site missiles, most of which are capable of carrying fairly accurate multiple independently targetable reentry vehicles (MIRVs), has twofold significance in the context of first-strike stability: First, this preference has provided the Soviets with approximately 5000 hard-target-kill-capable RVs, more than enough to effectively attack the 1000 U.S. ICBM silos and other hardened targets of strategic importance. At the same time, nearly three-quarters of all Soviet strategic forces are potentially vulnerable to attack.[5]

The U.S. strategic force mix is much more balanced. Weapons deployed aboard SSBNs account for roughly half of the U.S. SW total, while nearly 30 percent of the total is assigned to bombers and only 20 percent to land-based missiles in fixed silos. We assume that only 1650 U.S. RVs (all on ICBMs) possess sufficient accuracy and yield to effectively target the nearly 1400 Soviet ICBM silos, as well as other hardened Soviet assets.

We now assess the stability of current postures of strategic forces. We examine two scenarios: attack options against forces at normal peacetime alert rates and attack options against forces at elevated, or generated, alert rates.[6]

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[4]See Appendix A, tables A.1 and A.2.

[5]According to several authoritative sources, future Soviet strategic offensive forces may look somewhat different. While the Soviets will continue to rely on fixed, silo-based ICBMs, most observers expect that they will deploy mobile ICBMs in large numbers and make major improvements to their sea-based and bomber forces. Included among these changes are the fielding of more, and more accurate, MIRVed SLBMs and an increase in the number of weapons carried by the bomber force as a result of the deployment of bombers with long-range, modern cruise missiles. See Robert M. Gates and Lawrence K. Gershwin, "Soviet Strategic Force Developments," testimony before a Joint Session of the Subcommittee on Strategic and Theater Nuclear Forces of the Senate Armed Services Committee and the Defense Subcommittee of the Senate Committee on Appropriations, June 26, 1985, and U.S. Department of Defense, *Soviet Military Power 1986*, Government Printing Office, March 1986.

[6]In analyzing these hypothetical U.S. and Soviet first strike attack options, we make several simplifying assumptions. A description of the attack scenarios and the major assumptions involved in this analysis may be found in Appendix B.

Normal Peacetime SSBN and Bomber Alert Rates

Figure 2 displays U.S. and Soviet first-strike attack options, given the current posture of strategic nuclear forces and normal peacetime alert rates. On the curve labeled Soviet first-strike attack options, the point in the upper right represents a pure Soviet countervalue attack. With such an attack, the Soviets would place all 16,000 of their SWs on U.S. value targets and none on U.S. strategic offensive forces. By allocating their weapons in this manner, the Soviets would maximize the damage inflicted on U.S. value targets. In such an attack, however, all 13,000 U.S. SWs would survive and could potentially be used against value targets in the Soviet Union. Therefore, although the Soviets would have maximized the damage inflicted on the United States by attacking only U.S. value targets, they would have done nothing to limit damage from a U.S. retaliatory attack.

To limit damage inflicted on the Soviet Union from a U.S. retaliatory attack, the Soviets might attack some or all of the various elements of the U.S. strategic offensive force structure. Figure 2 displays the Soviet ballistic missile attack options against the specific U.S. force elements, arranging these attack options from most attractive in the upper right to least attractive in the lower left.

From the slopes of the segments of the Soviet ballistic missile attack-option curve, one can determine the Soviet price to attack each element (in terms of Soviet SWs used) and its effectiveness (in terms of U.S. SWs destroyed). The price that the Soviets would have to pay is reflected by movement toward the origin along the x-axis (Soviet potential standard weapons on U.S. value targets). The number of U.S. SWs destroyed as the Soviets focus their attack on U.S. forces can be seen in the movement down the y-axis (U.S. potential standard weapons on Soviet value targets). The smaller the ratio of attacking Soviet SWs relative to U.S. SWs destroyed, the more attractive the Soviets would find attacking the U.S. force element in question.

If the Soviets were to strike first, they would find it extremely cost effective to attack U.S. SSBNs in port and bombers, both those not on alert and those on alert at coastal bases.[7] Bombers on the ground and submarines in port are both vulnerable to attack and lucrative targets; attacks on these elements would therefore yield high returns. For example, a single U.S. Poseidon-class submarine is equipped with 16 SLBMs, each accounting for 8 to 14 SWs. The Soviets could destroy several of these boats, using only a few SWs against a U.S.

[7]Alert bombers at coastal bases are assumed destroyed on the ground because of the extremely short flight time of SLBMs targeted at these bases from Soviet SSBNs patrolling off the U.S. coast; see Appendix B.

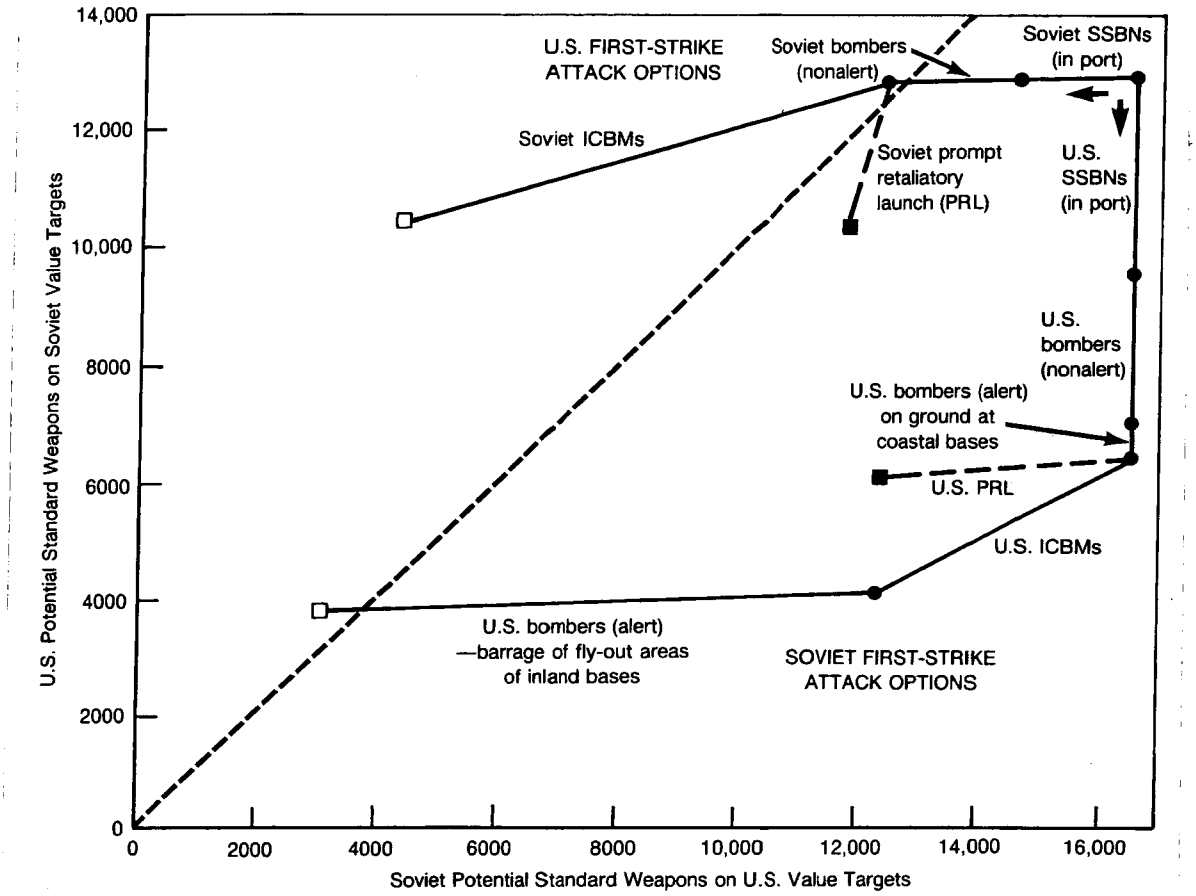

Fig. 2—U.S. and Soviet First-Strike Attack Options, Given Current Strategic Offensive Forces and Normal Peacetime Alert Rates

SSBN base. Moreover, in peacetime, at normal alert rates, significant numbers of U.S. bombers and SSBNs are located at relatively few air and naval bases.

The empty square at the leftmost point on the Soviet attack-option curve represents a pure Soviet counterforce attack. At this point, the Soviets would have placed all available ballistic missile SWs on U.S. strategic force targets and few, if any, SWs on U.S. value targets. Nearly 4000 U.S. SWs would probably survive and could potentially be used against Soviet value targets. (The U.S. total consists largely of SWs associated with SSBNs on patrol and bombers on strip alert at inland bases.) Furthermore, if the United States could launch its ICBMs prior to their destruction by incoming Soviet warheads—a capability

frequently referred to as prompt retaliatory launch (PRL)—U.S. retaliatory capability could remain as high as nearly 6000 SWs.[8]

Given the Soviet ballistic missile attack options ranging from pure countervalue to pure counterforce, as displayed in Fig. 2, the question then becomes: If a Soviet leader decided to attack, where on this curve would he choose to operate? Said somewhat differently, what from a Soviet standpoint, would be the optimal allocation of weapons (1) against U.S. strategic nuclear force targets and (2) against U.S. value targets? The overarching question is, of course, would the Soviets attack in the first place?

Based on the discussion above, we know that the central Soviet objectives in any attack would be to maximize damage to the United States while minimizing potential damage to themselves. In terms of our format, outcomes represented by points on the Soviet attack-option curve closest to the x-axis, while remaining as far to the right as possible, would best meet these Soviet objectives.

The Soviet attack-option curve displayed in Fig. 2 comes closest to the preferred area in the lower right at the point in this curve after the Soviets have attacked U.S. SSBNs in port, nonalert bombers, alert bombers at coastal bases, and ICBMs. At this point, the Soviets would allocate roughly 4000 SWs to U.S. strategic force targets and leave themselves with the potential to place over 12,000 SWs on U.S. value targets. This attack would draw down the U.S. potential to attack Soviet value targets from nearly 13,000 SWs to between roughly 4000 and 6000 SWs, depending on whether U.S. ICBMs were launched out from under the Soviet attack.

If the Soviets placed even more value on limiting damage to themselves at the expense of inflicting damage on the enemy, they might increase the portion of their strike devoted to attacking U.S. strategic offensive forces. Specifically, in addition to attacking the U.S. force elements cited above, the Soviets might also barrage fly-out areas of alert U.S. bombers at inland bases. As the shallow slope of this portion of the curve attests, however, the Soviets might not deem an attack on this U.S. force element cost effective; i.e., while limiting damage only slightly, it would greatly reduce the portion of the Soviet strategic arsenal available to hit U.S. value targets.

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[8]A PRL policy is depicted in this format by the dashed lines labeled U.S. and Soviet PRL. A PRL doctrine would have the practical effect of decreasing the number of an attacker's potential standard weapons with little or no change in the number of SWs possessed by the side under attack, i.e., the attacker would have used large numbers of weapons to attack the other's silos that once contained missiles. These missiles would now be headed toward the attacker's homeland.

The upper curve in Fig. 2 displays U.S. first-strike attack options with ballistic missiles against Soviet strategic forces that are under normal peacetime alert rates. The rightmost point on this curve represents a pure countervalue attack option; the leftmost point (the empty square), a pure counterforce attack. Soviet bombers (none of which is assumed to be on alert) and SSBNs in port, like their U.S. counterparts, represent vulnerable and lucrative targets. Importantly, the U.S. counterforce attack against Soviet ICBMs would not destroy as high a percentage of the Soviet ICBM force as the percentage of U.S. ICBMs that a Soviet attack would destroy. This asymmetry results from the fact that the United States lacks enough RVs capable of a two-on-one attack on all Soviet ICBM silos.

The United States shares the same broad attack objectives as those postulated for the Soviet Union (that is, to maximize damage inflicted while minimizing damage incurred), and the upper left region of Fig. 2 represents the U.S. preferred attack outcome. From this perspective, the optimal U.S. attack option would be one in which the United States targeted the Soviet Union's SSBNs in port, bombers, and silo-based ICBMs. With this type of attack, the United States would allocate 2500 SWs against Soviet offensive forces and would have the potential to place nearly 10,500 SWs on Soviet value targets. Depending on whether they launched their ICBMs out from under the U.S. attack, the Soviets could launch a retaliatory strike consisting of some 4000 to nearly 12,000 SWs.

This examination of current U.S. and Soviet first-strike attack options, given normal peacetime SSBN and bomber alert rates, suggests that although each side could achieve a simple numerical advantage by attacking first, neither could substantially limit damage to itself by striking first. Even in this case of a massive U.S. or Soviet first strike against strategic forces at peacetime alert rates, and assuming that neither side launched its ICBMs out from under the other's attack, roughly 4000 of the other side's SWs would survive—clearly a robust retaliatory capability.

Under these circumstances, neither side would likely perceive the other as facing much pressure or temptation to attack first, since the numerical advantage that either might gain by striking first would have little operational significance under the threat of unparalleled destruction of homeland assets. Thus, given current U.S. and Soviet forces and normal peacetime alert rates, no undue degree of first-strike instability would arise in a crisis.

Generated SSBN and Bomber Alert Rates

Figure 3 illustrates the relative level of first-strike instability when current U.S. and Soviet strategic offensive forces operate at generated alert rates. For the sake of simplicity, we now assume that roughly 75 percent of on-line U.S. SSBNs and 60 percent of Soviet SSBNs are on patrol. We assume also that approximately 60 percent of U.S. and 50 percent of Soviet bombers are on strip alert.[9]

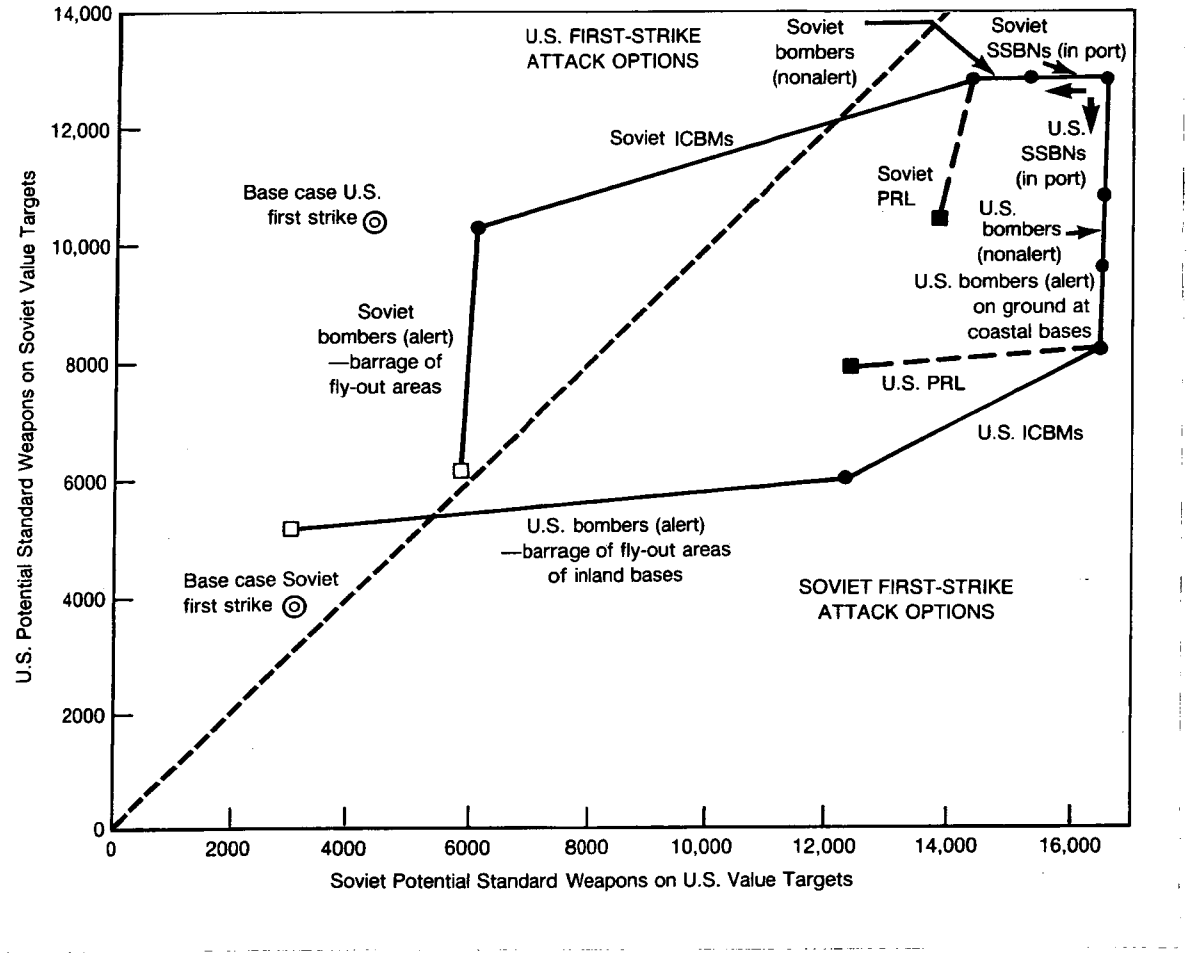

Fig. 3—U.S. and Soviet First-Strike Attack Options, Given Current Strategic Offensive Forces and Generated SSBN and Bomber Alert Rates

[9]Assumptions about the nature of the attack are generally similar to those for the preceding scenario; see Appendix B.

The effect on first-strike stability of generated bomber and submarine alert rates may be seen by comparing U.S. and Soviet ballistic missile attack-option curves in Fig. 3 with those of Fig. 2, above. The major difference between the curves in these two scenarios is the length of the segments on the U.S. and Soviet first-strike attack option curves depicting each side's attack against the other's SSBNs in port and nonalert bombers. These segments are much shorter in the case of generated alert rates than in the case of normal alert rates.[10]

The difference between Figs. 2 and 3 indicates that under generated alert conditions, fewer U.S. and Soviet SLBM and bomber weapons would be vulnerable to a first-strike. The reduced vulnerability of U.S. and Soviet forces means that more of each side's total force would probably survive the other's first strike. By comparing the end points of each side's attack for the two cases, one can see that U.S. and Soviet retaliatory capability without PRL would increase from roughly 4000 SWs to over 5000 SWs.

In addition, the end point of the Soviet attack-option curve under generated alert conditions (and, to a lesser extent, under normal peacetime alert conditions) reaches far across the 45-degree line. The position of this end point indicates that the Soviets would be at a numerical disadvantage after their attack if they chose to barrage bomber fly-out areas. Moreover, the proximity of the U.S. curve's end point to the 45-degree line reveals that the United States would be in a similar position after a U.S. first strike if the Soviets were to marginally increase their bomber and SSBN alert rates.

Not surprisingly, then, upgrading the alert status of U.S. and Soviet strategic offensive forces enhances first-strike stability. Because generated alert rates increase the number of each side's weapons surviving an enemy first strike, the superpowers have even less motivation to strike first in a crisis than they have in the scenario with normal alert rates.

EFFECT ON FIRST-STRIKE STABILITY OF CHANGES IN BASE CASE ASSUMPTIONS

Low-Observable Sea-Launched Cruise Missiles and Enhanced SSBN Localization Capability

To provide a worst-case analysis, we make two changes in the current posture of U.S. and Soviet strategic offensive forces and assess the effect of these changes on first-strike stability. The changes involve (1) the improvement of U.S. and Soviet antisubmarine warfare (ASW) capability to enable each side to localize the other's SSBNs on patrol to

[10]To compare the relative first-strike stability of this and subsequent scenarios with that of the first scenario, we represent the attack-option curve end points of the latter in ensuing figures by two concentric circles labeled base case U.S./Soviet first strike.

within a 50-mile radius and (2) the U.S. and Soviet deployment of 50 low-observable ("stealthy"), highly accurate sea-launched cruise missiles (SLCMs) each.[11]

The following assumptions accompany the two changes:

- The use of stealthy SLCMs enables the Soviets to effectively attack U.S. strategic bombers on alert at inland bases.
- The United States uses most, if not all, of its 50 SLCMs to target heavily MIRVed fixed-site Soviet ICBMs. The two sides employ their SLCMs differently because the United States cannot effectively target all Soviet ICBMs with its present ballistic missile force.
- The hypothetical addition of SLCMs to each side's strategic inventory does not increase either country's inventory of standard weapons on launchers accountable under the strategic arms limitation treaties (SALT I and SALT II).
- Normal peacetime alert rates apply to the forces of the country incurring the first strike.

Figure 4 displays the effect of the two changes on U.S. and Soviet attack options for the normal alert rate scenario. In the case of a U.S. first strike, the addition of SLCMs has increased the number of Soviet ICBMs that can be targeted effectively. Nevertheless, attacking Soviet SSBNs remains a costly proposition. Even with the 50-mile localization capability, the United States must expend the equivalent of approximately 600 Minuteman III SWs to destroy a Soviet submarine that may have as few as 17 SWs associated with it.[12]

In the case of a Soviet first strike, the Soviets' deployment of low-observable SLCMs could enable them to destroy the entire U.S. strategic bomber force before it could leave the ground. The capability to localize U.S. SSBNs on patrol, each of which carries 16 or 24 highly MIRVed missiles, would allow the Soviets to destroy between 128 and 224 U.S. SWs for every 760 SS-18 SWs that they expended in their attack. Given the postulated capability to localize SSBNs at sea to within a 50-mile radius, the Soviets could attack alert U.S.

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[11]A low-observable SLCM is one able to avoid detection until detonation on target. The presence of SLCMs necessitates some slight modification of the basic ballistic missile attack scenario; see Appendix B. We are aware of the possible operational inconsistency involved in having the capability to localize SSBNs without the ability to detect SLCM launches. Our purpose in presenting this case is merely to portray the effect of a worst-case scenario on first-strike stability.

[12]See Richard L. Garwin, "Will Strategic Submarines Be Vulnerable?" *International Security,* Vol. 8, No. 2, Fall 1983.

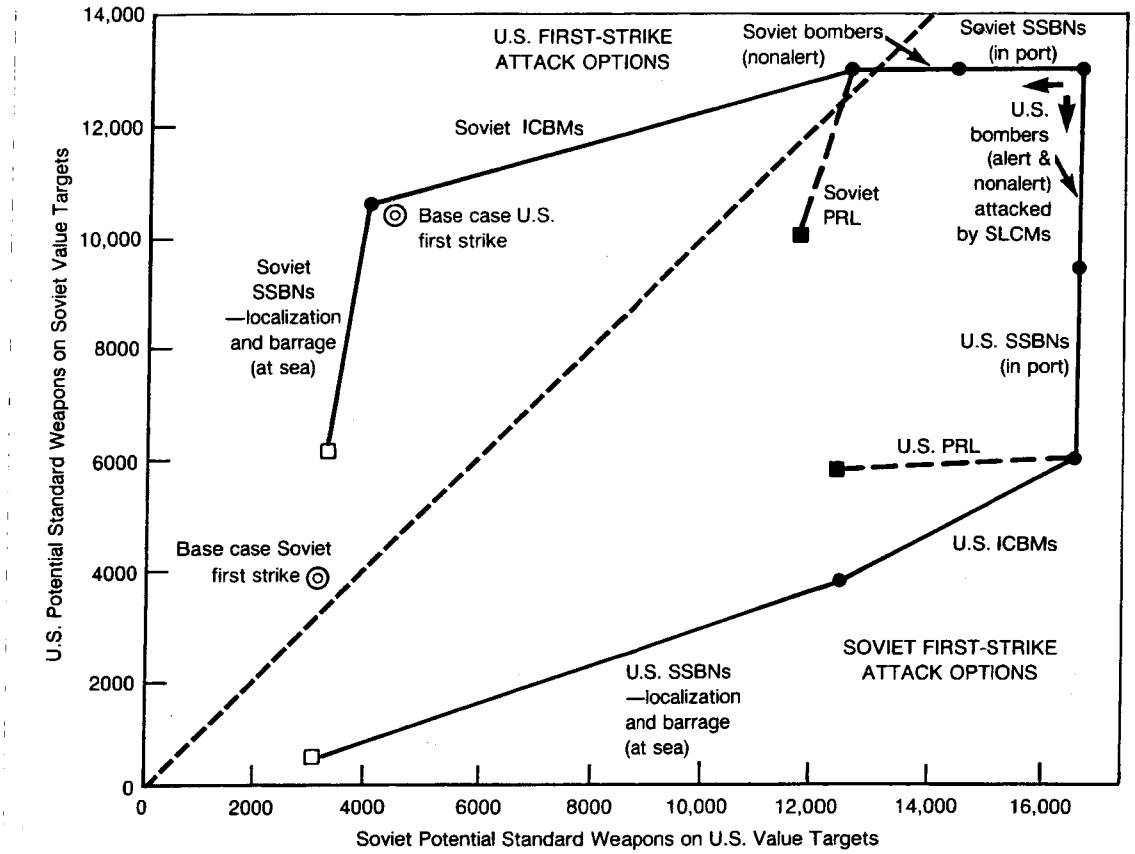

Fig. 4—U.S. and Soviet First-Strike Attack Options if Both Deploy Low-Observable SLCMs and Can Localize SSBNs

SSBNs almost as cost effectively as they could attack U.S. Minuteman ICBMs in existing silos. Thus, in Fig. 4, the slopes of the curve segments representing Soviet attacks on U.S. SSBNs on patrol and U.S. ICBMs are roughly equal.

The effect on first-strike stability of the two force changes may be observed by comparing the end points of the U.S. and Soviet attack option curves obtained in this case with those in the base case for existing forces at normal alert rates. Assuming no PRL in either case, the number of U.S. or Soviet SWs surviving a first strike by the other falls drastically from 4000 SWs each to 500 SWs for the United States and roughly 3000 SWs for the Soviet Union. Each side would now be able to effectively target and destroy much

larger portions of the other's strategic force. In fact, in this postulated situation, the Soviets would be close to possessing a disarming first-strike capability—a capability that could promote an alarming degree of first-strike instability.

Increased U.S. Hard-Target-Kill Capability

In this case, we examine the effect on first-strike stability of the United States replacing several thousand existing ICBM and SLBM RVs with warheads more capable than the present ones of attacking hardened Soviet missile silos while the Soviet Union made no changes to its existing force posture. We assume that the United States replaces 100 Minuteman III ICBMs with 100 MX ICBMs and also substitutes 360 D-5 SLBMs for an equal number of C-3 and C-4 missiles.[13] As a result, the U.S. strategic inventory still contains nearly 13,000 SWs, including approximately 9000 SWs associated with ballistic missiles—totals similar to those in the base case, despite the U.S. force modernization described above.

The effect of this enhancement of U.S. hard-target-kill capability without the concurrent modernization of Soviet basing modes is displayed in Fig. 5. Not surprisingly, the improved U.S. ballistic missile force now holds at risk a much larger portion of the Soviet strategic arsenal, including virtually all of the nearly 1400 fixed-site Soviet ICBMs. In a hypothetical U.S. ballistic missile strike against Soviet forces at normal peacetime alert rates, fewer than 1500 Soviet SWs would survive—assuming no Soviet PRL. The relatively few Soviet SWs that would survive a U.S. first strike in this scenario consist largely of those assigned to SLBMs aboard patrolling SSBNs, as well as those associated with a few surviving ICBMs.

Because no changes were made in the Soviet force posture and U.S. ICBM basing modes were not improved, the Soviet first strike in this case is nearly identical to that shown in the base case. If the United States did not carry out a prompt retaliatory launch of its ICBMs, around 4000 U.S. SWs would survive the hypothetical Soviet first strike in this scenario.

The disparity in force postures represented in this scenario, were the Soviets to allow it to develop, would promote first-strike instability. Unilateral U.S. force modernization would increase the vulnerability to attack of existing Soviet forces. The Soviets' failure to move toward more survivable basing modes for their strategic forces would heighten the

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[13]These replacements continue the U.S. compliance with the SALT I and II constraints and keep the total number of U.S. SWs consistent with the number in the base case force posture; see Appendix A, Table A.3.

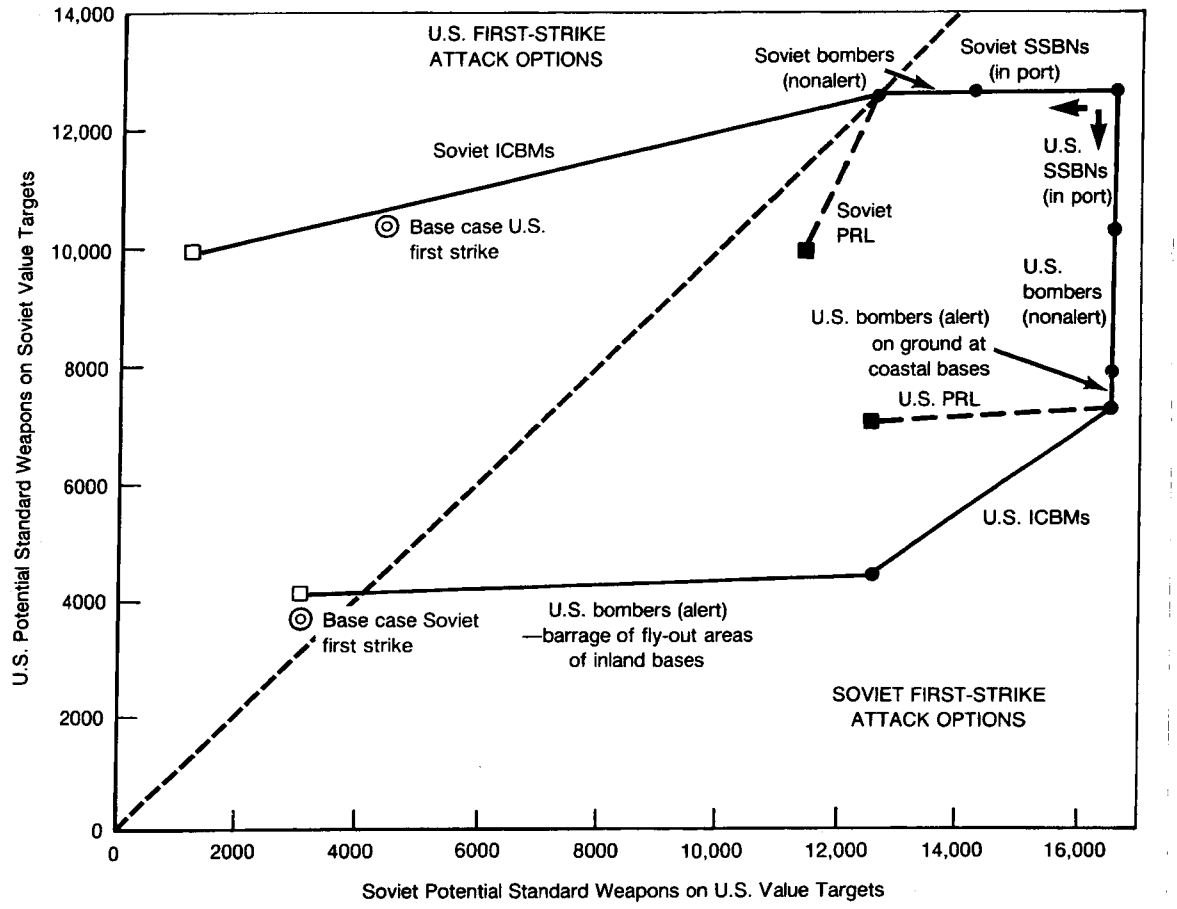

Fig. 5—U.S. and Soviet First-Strike Attack Options, Given Increased U.S. Hard-Target-Kill Capability Without ICBM Basing Modernization

pressure on Soviet leaders to preempt in a crisis out of their perception that the United States was tempted to exploit Soviet vulnerability. Moreover, the same Soviet force vulnerability might put pressure on U.S. leaders to attack first in a crisis, since they might consider Soviet preemption to be imminent.

To enhance the survivability of their strategic forces—thereby preventing the erosion of first-strike stability—both the United States and the Soviet Union have the following broad options:

- Increasing the survivability of their ICBM forces through mobility, redundant silos, terminal interceptors, or some combination of these to increase the price to attack this force element.[14]
- Raising the proportion of existing bomber and SSBN forces that are on day-to-day alert.
- Constraining the threat to the survivability of their forces through meaningful arms control limitations that reduce the price each side can pay to attack the other.

EFFECT ON FIRST-STRIKE STABILITY OF STRATEGIC ARMS REDUCTIONS

We explore below the effect on first-strike stability of significantly reducing modernized U.S. and Soviet strategic offensive forces under present-day, normal peacetime alert rates and in the absence of any improvement of their basing modes. Later, we examine the relative level of first-strike stability when reductions are coupled with modernization of basing modes and increased alert rates. The arms control constraints imposed here are related to the terms agreed to in principle at the 1986 Reykjavik summit limiting each side to 6000 accountable weapons on ballistic missiles, ALCM-equipped bombers, and non-ALCM bombers.

U.S. and Soviet Force Modernization Without Modernized ICBM Basing

The constrained U.S. force in this scenario consists of ICBMs, SLBMs, and bombers in proportions roughly similar in terms of weapons accountable under the Strategic Arms Reduction Talks (START) to that of today's U.S. force posture. The U.S. strategic ballistic missile force consists of 1367 ICBM SWs assigned to 50 MX and 289 Minuteman III ICBMs, based in 339 existing Minuteman-type silos, and 2880 SLBM SWs associated with C-4 and D-5 SLBMs aboard 16 SSBNs. Of the over 4200 ballistic missile weapons, all of the ICBM RVs and one-third of the SLBM RVs are hard-target killers.[15]

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[14]According to one calculation, at least 4500 perfect interceptors (i.e., each with a kill probability of 1.0) would be required to ensure the survivability of just one-half of the U.S. ICBM force from the roughly 5000 hard-target-kill-capable RVs on the Soviet SS-18 and SS-19 force. See R.E. Strauch, *"Shell Game" Aspects of Mobile Terminal ABM Systems,* The RAND Corporation, RM-5474-ARPA, December 1967.

[15]See Appendix A, Table A.4.

The composition of the constrained Soviet force reflects the assumption that the Soviets would continue to emphasize land-based rocket forces. Of the nearly 6500 ballistic missile SWs retained, the Soviets have assigned 5000 to land-based forces and only 1500 to sea-based forces. A total of approximately 4500 Soviet ICBM SWs, all associated with ballistic missiles carrying RVs capable of attacking hardened U.S. targets, are deployed in only 325 existing-type silos. The remaining ICBM element consists of 350 road-mobile SS-25s, 25 percent of which are deployed out-of-garrison in peacetime over 20,000 square nautical miles.[16]

Figure 6 displays U.S. and Soviet first-strike attack options with ballistic missiles against the forces described above under present-day, normal peacetime alert rates. According to this figure, although the Soviets can destroy several thousand U.S. SWs in a first strike by expending a relatively small portion of their total arsenal, the diversity of U.S. forces ensures that some 2000 U.S. SWs would probably survive to be used against Soviet value targets.

A U.S. first strike, in contrast, could be so effective as to reduce Soviet retaliatory capability to approximately 500 SWs—assuming that the Soviets did not launch their ICBM force out from under the U.S. attack. Only the relatively few SWs assigned to Soviet out-of-garrison SS-25s and SSBNs on patrol would be likely to survive a U.S. first strike.

Given the increased U.S. hard-target-kill capability and a Soviet force posture that emphasized large, highly MIRVed ICBMs (including the new, ten-warhead SS-24) deployed in a few hundred existing-type silos, the Soviets might well believe that the United States possessed a rather threatening first-strike capability.

This scenario demonstrates that merely reducing U.S. and Soviet offensive forces does little to decrease—and may actually increase—first-strike instability. The U.S. posture, because of the diversity of the force mix, would pose few pressing problems in the presence of such strategic force reductions. Soviet forces, however, would be extremely vulnerable under these circumstances. A U.S. first strike could destroy a large portion of the Soviet strategic force. Thus, current basing modes coupled with meaningful arms reductions could produce a worrisome degree of first-strike instability.

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[16]See Appendix A, Table A.5.

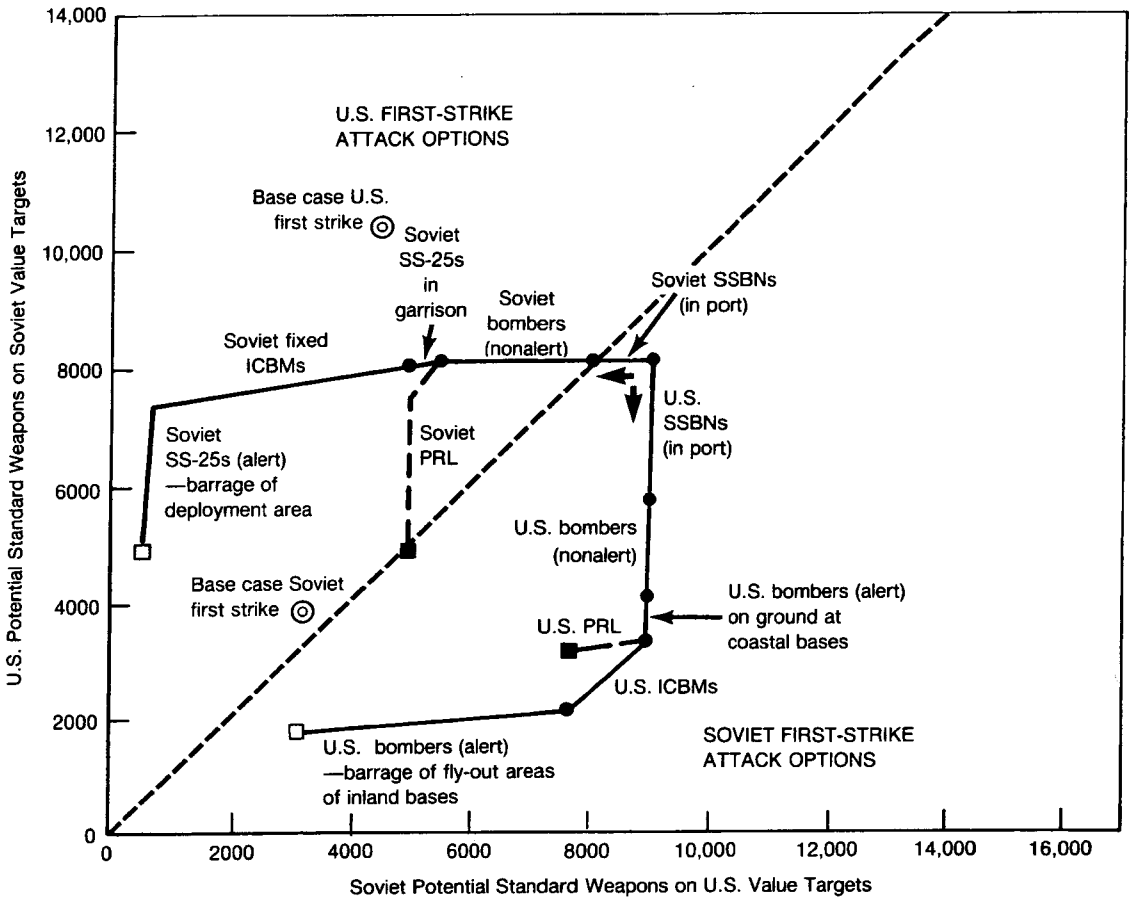

Fig. 6—U.S. and Soviet First-Strike Attack Options, Given START "6000" Constraints and Force Modernization Without ICBM Basing Modernization

U.S. and Soviet Force Modernization With Modernized ICBM Basing and Increased Alert Rates

The notional force postures in this scenario illustrate the effect on first-strike stability of arms reductions and modernized U.S. and Soviet forces, combined with increased alert rates and modernized ICBM basing modes, improvements that would significantly raise the price to attack. The composition of the U.S. and Soviet forces under this arms control regime is virtually unchanged from the previous case. In this scenario, however, both superpowers have increased the portion of their bomber and SSBN forces on alert in peacetime and have deployed a substantial portion of their ICBMs on mobile launchers or in super-hard silos.[17]

[17]See Appendix A, Table A.6.

On the U.S. side, 501 single-RV, small ICBMs (SICBMs) under a 100 percent alert rate replace the same number of Minuteman III warheads; the SICBMs are mounted on hardened transporters deployed randomly over 10,000 square nautical miles. Silos containing the 50 MX missiles and the remaining 122 Minuteman ICBMs are super-hardened.

We assume that the Soviets have deployed their much larger ICBM force in a similar manner. Like the United States, the Soviet Union has super-hardened its silos and increased, through mobile basing, the number of land-based aim points that the attacker would have to target. Whereas in the previous case SS-24s were assumed to be in silos, in this scenario the Soviets have deployed them on rail-mobile launchers on continuous alert.

Soviet and U.S. peacetime alert rates—applied to the forces of the first-strike victim—in this scenario correspond to the generated alert rates of previous cases. The Soviets have increased the peacetime alert rates of their SSBNs and bombers, placing over one-half of these two force elements on alert. In addition, the Soviets have increased the peacetime alert rate of their road-mobile SS-25 ICBMs from 25 percent to 50 percent.

As Fig. 7 demonstrates, a Soviet first strike on U.S. strategic forces would result in the destruction of some 5000 U.S. SWs. Approximately 3000 U.S. SWs would remain, however, for potential use in retaliation against Soviet value targets.

Similarly, over 3000 Soviet SWs would survive a U.S. first strike, even if the United States barraged SS-24 or SS-25 deployment areas and the Soviets did not launch their ICBMs out from under the U.S. attack. Moreover, if the United States barraged Soviet bomber fly-out areas rather than mobile missile deployment areas (resulting in the maximum Soviet SWs killed), the Soviet Union would still have 2700 SWs remaining.

The U.S. and Soviet shift to mobile ICBMs would greatly decrease the percentage of each side's ICBM force that could be readily targeted by the other side. Arms reductions, moreover, would diminish each side's capability to barrage mobile ICBM deployment areas by reducing the attack price that each would be able to pay. Since mobility in the presence of arms reductions would reinforce first-strike stability, it would be disadvantageous for either side to develop the capability to effectively target with ICBM RVs the other's mobile ICBMs.

In summary, a superpower agreement substantially reducing force levels must be formulated so as to ease the pressure or temptation facing the superpower leaderships to strike first in a crisis. In the presence of substantial reductions, the Soviets would have to consider some combination of deploying a greater proportion of their strategic offensive

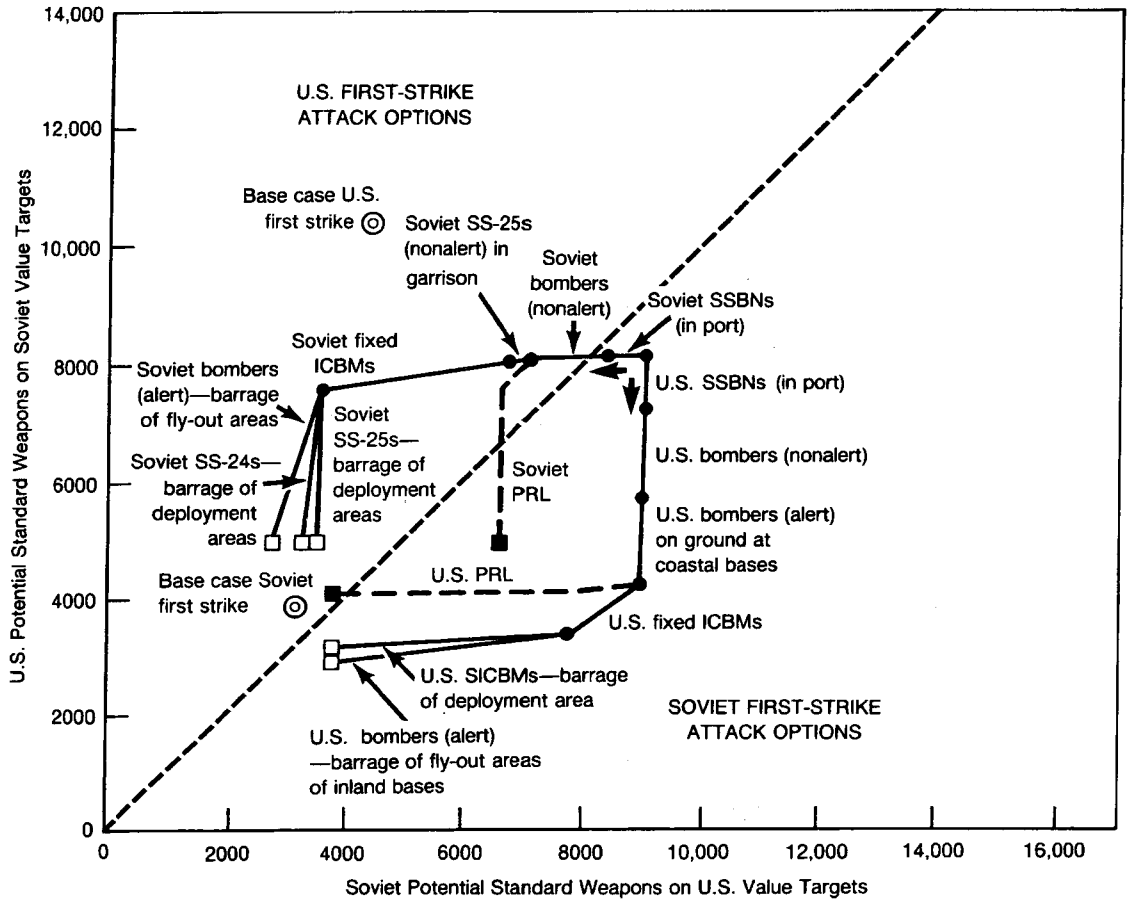

Fig. 7—U.S. and Soviet First-Strike Attack Options, Given START "6000" Constraints, Force and ICBM Basing Modernization, and Increased Alert Rates

forces on alert SSBNs and bombers and replacing fixed-site, highly MIRVed ICBMs with mobile ICBMs that raise the price to attack.[18] As noted above, the U.S. force would remain fairly diverse; the United States should maintain this force mix, increase SSBN and bomber alert rates, and raise the Soviet price to attack U.S. forces, particularly ICBMs. To prevent the erosion of first-strike stability, therefore, changes in composition and basing modes must accompany deep reductions in U.S. and Soviet strategic forces.

[18]The Soviets have already begun to address the potential vulnerability of their strategic offensive forces with the deployment of mobile ICBMs and more capable sea-based and bomber forces. See Gates and Gershwin, "Soviet Strategic Force Developments" and *Soviet Military Power 1986* for further discussion of Soviet forces and future trends.

III. CONCLUSIONS

For the purpose of analyzing the relative merit of alternative force postures, first-strike stability, as demonstrated above, is a more relevant and demanding criterion than the usual concept of deterrence. The quantitative analysis of *relative* stability or instability emanating from alternative strategic force postures can serve two important functions.

First, such analysis can make leaders aware that the choice in a crisis is more complicated than the usual concept of deterrence suggests. The concept of first-strike stability, rather than implying that waiting carries no risk, emphasizes the more relevant situation in which a leader has perceived that his country may already be at risk. Thus, it focuses attention on the extent to which the potential cost associated with waiting and incurring a first strike exceeds the cost of going first.

Second, the analysis may promote more informed decisions about the merits of alternative force postures. For example, if deterrence is used as the yardstick, the vulnerability of Soviet silos to the MX and D-5 raises little concern. According to the concept of first-strike stability, however, given that vulnerability, the Soviet leader might believe that the United States would be tempted to strike first in a crisis, thereby creating pressure on him to preempt; i.e., the existence of the MX and D-5 might lead a Soviet leader to conclude that his country was already at risk because the United States might find striking first much less costly than incurring a first strike.

As shown in the base case of this Note, the current disposition of U.S. and Soviet forces demonstrates no pressing problem with regard to the more demanding criterion of first-strike stability. Even under normal peacetime alert rates—and without prompt retaliatory launch—neither superpower could substantially reduce the damage to itself by going first. In a crisis, neither leader would have strong reason to believe that his counterpart was motivated to strike first, and he would feel no undue pressure to preempt to avoid incurring such an attack. Both sides obviously would order generated alert rates for their forces during a prolonged period of superpower tension. Generated alert rates would enhance stability, as both sides would have more survivable force postures, given the added SSBNs at sea and bombers on strip alert.

The force postures assumed in the third and fourth scenarios (SLCMs and SSBN localization in the third and increased U.S. hard-target-kill capability in the fourth) have several implications. First, although the current situation is relatively stable (as depicted by

the base case), changes in how effectively one force could engage and destroy the strategic forces of the other might lead to instability. An obvious corollary to this point is that neither superpower can take first-strike stability for granted. Both the United States and the Soviet Union face critical choices concerning the postures of strategic nuclear forces in the months and years ahead. Depending on the force modernization options each pursues or does not pursue, the superpowers can do much to enhance or erode first-strike stability.

Second, a breakthrough in Soviet ASW capabilities could cause first-strike instability. The SLBMs aboard U.S. SSBNs on patrol constitute a large portion of U.S. retaliatory capability. Given the Soviets' substantial barrage capability, an improved ability to localize the few SSBNs that the United States is likely to have at sea would seriously threaten this U.S. retaliatory capability.

Third, low-observable SLCMs also have the potential to generate first-strike instability. Soviet deployment of even 50 stealthy, highly accurate SLCMs could severely threaten a currently survivable leg of the U.S. strategic triad. Because such systems presumably could avoid detection by U.S. sensors, both at launch from submarines and during flight to targets, they would greatly reduce attack warning time. The entire U.S. bomber force, as currently deployed and operated, including those on alert at inland bases, could be highly vulnerable to such an attack. In other words, nearly one-third of the U.S. SW total could be held at risk by 50 weapons of a type not included in previous arms control agreements. Accordingly, the United States should make every effort to maintain the capability for adequate warning for positive control launch of its bombers—and against all threats.

Last, as demonstrated in the final two scenarios, arms control alone does not necessarily promote first-strike stability. While meaningful reductions might calm public apprehension over the current nuclear relationship, they might also erode first-strike stability in the absence of increased alert rates and modernized basing modes. The United States and the Soviet Union may be expected to preferentially retain systems with hard-target-kill capability, for example, the MX, D-5, SS-18, and SS-19. Under these circumstances, survivability measures become extremely important, especially in the presence of an arms accord mandating large force reductions. Thus, proper attention to each other's postures and to unilateral survivability enhancements must accompany any arms control agreement between the superpowers.

In summary, this study proposes a more rigorous approach for evaluating the merits of alternative U.S. and Soviet strategic offensive force postures. We believe that this approach will promote more sensible decisions regarding alternative force postures and contribute to the establishment of arms control regimes that uphold first-strike stability.

Appendix A

U.S. AND SOVIET STRATEGIC FORCE POSTURES

The breakdown of 1986 U.S. and Soviet strategic offensive forces presented in Tables A.1 and A.2 is based on force figures in U.S. Department of Defense, *Soviet Military Power 1986*, U.S. Government Printing Office, March 1986; *United States Military Posture FY 1987*, Organization of the Joint Chiefs of Staff, 1986; *The Military Balance 1985-86*, International Institute for Strategic Studies, London, 1985; *Modernizing U.S. Strategic Offensive Forces: Costs, Effects, and Alternatives*, Congressional Budget Office, November 1987; and *Jane's All the World's Aircraft 1986-87*, Jane's Publishing Company Limited, London, 1986. The notional future U.S. and Soviet force postures in the remaining tables in this appendix are used only for the purpose of illustration.

In each appendix table, the standard weapon value for ballistic missiles is the larger of two numbers: (1) the maximum number of weapons tested on the missile or (2) the throwweight of the missile in kilograms divided by 400 for MIRVed missiles and 500 for single-RV missiles. The standard weapon value for bombers is the take-off gross weight in kilograms divided by 11,350 for ALCM carriers and 22,700 for aircraft that do not carry cruise missiles.

Table A.1

BASE CASE: 1986 U.S. STRATEGIC FORCES

Force	Number	Throwweight (1000 kg) per Missile	Throwweight (1000 kg) Total	Actual or Estimated Weapons	SALT Weapons per Missile	SALT Weapons Total	Standard Weapon Stations per Missile	Standard Weapon Stations Total
ICBMs								
Minuteman II	450	.7	315		1	450	1.4	630
Minuteman III	550	1.1	605		3	1650	3.0	1650
Total	1000		920	2100		2100		2280
SLBMs								
C-3	288	1.5	432		14	4032	14.0	4032
C-4	360	1.4+	504		8	2880	8.0	2880
Total	648		936	5700		6912		6912
Total ballistic missiles	1648		1856	7800		9012		9192
		Takeoff Gross Weight (1000 kg) per Bomber	Takeoff Gross Weight (1000 kg) Total				per Bomber	Total
Bombers (active)								
B-52G (ALCM)	98	222	21756				19.5	1911
B-52G	69	222	15318				9.8	676
B-52H	96	222	21312				9.8	941
Total	263		58386	3300				3528
Total missiles and bombers	1911			11100				12720

Table A.2

BASE CASE: 1986 SOVIET STRATEGIC FORCES

Force	Number	Throwweight (1000 kg) per Missile	Throwweight (1000 kg) Total	Actual or Estimated Weapons	SALT Weapons per Missile	SALT Weapons Total	Standard Weapon Stations per Missile	Standard Weapon Stations Total
ICBMs[a]								
SS-11	448	1.1	493		1	448	2.2	986
SS-13	60	.5	30		1	60	1.0	60
SS-17	150	2.7	405		4	600	6.7	1005
SS-18	308	7.6	2341		10+	3080	19.0	5852
SS-19	360	3.4	1224		6	2160	8.5	3060
SS-25	72	.7	50		1	72	1.4	101
Total	1398		4543	6400		6420		11064
SLBMs								
SS-N-6	304	.7	258		1	304	1.4	426
SS-N-8	292	.7	204		1	292	1.4	409
SS-N-17	12	1.1	13		1	12	2.2	26
SS-N-18	224	1.1	246		7	1568	7.0	1568
SS-N-20	80	2.3	184		9	720	9.0	720
SS-N-23	32	2.3	74		10	320	10.0	320
Total	944		979	2800		3216		3469
Total ballistic missiles	2342		5522	9200		9636		14533
		Takeoff Gross Weight (1000 kg) per Bomber	Takeoff Gross Weight (1000 kg) Total				per Bomber	Total
Bombers								
Bear H (ALCM)	40	188	7520				16.5	660
Bear	110	188	20680				8.2	902
Bison	30	159	4770				7.0	210
Total	180		32970	800				1772
Total missiles and bombers	2522			10000				16305

[a]SS-25 missiles are mounted on road-mobile, hardened launchers and are deployed over an area of 20,000 square nautical miles.

Table A.3

U.S. AND SOVIET STRATEGIC FORCES: INCREASED U.S. HARD-TARGET-KILL CAPABILITY; NO ICBM BASING MODERNIZATION

Force	Number	Throwweight (1000 kg) per Missile	Throwweight (1000 kg) Total	Actual or Estimated Weapons	SALT Weapons per Missile	SALT Weapons Total	Standard Weapon Stations per Missile	Standard Weapon Stations Total
U.S. Strategic Forces								
ICBMs[a]								
MX	100	3.6	360		10	1000	10.0	1000
Minuteman II	450	.7	315		1	450	1.4	630
Minuteman III	450	1.1	495		3	1350	3.0	1350
Total	1000		1170	2800		2800		2980
SLBMs								
C-3	160	1.5	240		14	2240	14.0	2240
C-4	128	1.4+	179		8	1024	8.0	1024
D-5	360	2.4	864		8	2880	8.0	2880
Total	648		1283	5500		6144		6144
Total ballistic missiles	1648		2453	8300		8944		9124
Bombers	(Same as Table A.1)							
Total missiles and bombers	1911			11600				12652
Soviet Strategic Forces								
ICBMs	(Same as Table A.2)							
SLBMs	(Same as Table A.2)							
Bombers	(Same as Table A.2)							

[a] MX missiles are deployed in existing-type silos.

Table A.4

U.S. STRATEGIC FORCES: MODERNIZED U.S. AND SOVIET STRATEGIC FORCES; START "6000" CONSTRAINTS; NO ICBM BASING MODERNIZATION

Force	Number	Throwweight (1000 kg) per Missile	Throwweight (1000 kg) Total	Actual or Estimated Weapons	SALT Weapons per Missile	SALT Weapons Total	Standard Weapon Stations per Missile	Standard Weapon Stations Total
ICBMs[a]								
MX	50	3.6	180		10	500	10.0	500
Minuteman III	289	1.1	318		3	867	3.0	867
Total	339		498	1350		1367		1367
SLBMs								
C-4	240	1.4+	336		8	1920	8.0	1920
D-5	120	2.4	288		8	960	8.0	960
Total	360		624	2900		2880		2880
Total ballistic missiles	699		1122	4250		4247		4247
		Takeoff Gross Weight (1000 kg) per Bomber	Takeoff Gross Weight (1000 kg) Total				per Bomber	Total
Bombers (active)								
B-52 (ALCM)	75	222	16650				19.5	1463
B-52	153	222	33966				9.8	1499
B-1B	100	217	21700				9.5	950
Total	328		72316	1750				3912
Total missiles and bombers	1027			6000				8159

[a] MX missiles are deployed in existing-type silos.

Table A.5

SOVIET STRATEGIC FORCES: MODERNIZED U.S. AND SOVIET STRATEGIC FORCES; START "6000" CONSTRAINTS; NO ICBM BASING MODERNIZATION

Force	Number	Throwweight (1000 kg) per Missile	Throwweight (1000 kg) Total	Actual or Estimated Weapons	SALT Weapons per Missile	SALT Weapons Total	Standard Weapon Stations per Missile	Standard Weapon Stations Total
ICBMs[a]								
SS-18	150	7.6	1140		10+	1500	19.0	2850
SS-19	75	3.4	255		6	450	8.5	637
SS-24	100	3.6	360		10	1000	10.0	1000
SS-25	350	.7	245		1	350	1.4	490
Total	675		2000	3300		3300		4977
SLBMs								
SS-N-20	60	2.3	138		9	540	9.0	540
SS-N-23	96	2.3	221		10	960	10.0	960
Total	156		359	1500		1500		1500
Total ballistic missiles	831		2359	4800		4800		6477
		Takeoff Gross Weight (1000 kg) per Bomber	Takeoff Gross Weight (1000 kg) Total				per Bomber	Total
Bombers								
Bear H (ALCM)	91	188	17108				16.5	1501
Blackjack[b]	108	217	23436				9.5	1026
Total	199		40544	1200				2527
Total missiles and bombers	1030			6000				9004

[a]SS-24 missiles are deployed in existing-type silos. SS-25 missiles are mounted on road-mobile, hardened launchers and deployed over an area of 20,000 square nautical miles.

[b]The Blackjack is assumed to have the same specifications as the B-1B.

Table A.6

MODERNIZED U.S. AND SOVIET STRATEGIC FORCES: START "6000" CONSTRAINTS; INCREASED ALERT RATES; ICBM BASING MODERNIZATION

Force	Number	Throwweight (1000 kg) per Missile	Throwweight (1000 kg) Total	Actual or Estimated Weapons	SALT Weapons per Missile	SALT Weapons Total	Standard Weapon Stations per Missile	Standard Weapon Stations Total
U.S. Strategic Forces								
ICBMs[a]								
MX	50	3.6	180		10	500	10.0	500
Minuteman III	122	1.1	134		3	366	3.0	366
SICBM	501	.5	250		1	501	1.0	501
Total	673		564	1350		1367		1367
SLBMs	(Same as Table A.4)							
Bombers	(Same as Table A.4)							
Soviet Strategic Forces								
ICBMs[b]	(Same as Table A.5)							
SLBMs	(Same as Table A.5)							
Bombers	(Same as Table A.5)							

[a]Silos containing MX and Minuteman missiles are super-hardened. SICBMs are mounted on road-mobile, hardened launchers and deployed over an area of 10,000 square nautical miles.

[b]Silos containing SS-18 and SS-19 missiles are super-hardened. SS-24 missiles are mounted on rail-mobile launchers deployed over an area equivalent to 20,000 square nautical miles.

Appendix B

ATTACK SCENARIOS AND ASSUMPTIONS

In this Note, we make the following general assumptions about U.S. and Soviet counterforce attacks:

- In the scenarios involving current strategic offensive forces, only select U.S. and Soviet ICBM RVs possess sufficient accuracy and yield to be used against hard targets, such as ICBM silos.
- In the scenarios in which forces have been modernized and hard-target-kill capability increased, nearly all U.S. and Soviet ICBM RVs and some U.S. SLBM RVs on alert SSBNs are capable of attacking hard targets.
- In all cases, the counterforce portion of the attack displayed in the figures ends when the attacker has attacked all possible counterforce targets or the attacker has expended all of his available and/or effective weapons.

We use two attack scenarios as a base case in assessing the first-strike stability of various U.S. and Soviet strategic offensive force postures: (1) U.S. or Soviet attack against the other's forces at normal peacetime alert rates and (2) U.S. or Soviet attack against forces at high rates of readiness.

In the case of a Soviet first strike against U.S. forces, we assume that:

- Under normal peacetime alert rates, 60 percent to 65 percent of on-line U.S. SSBNs are on patrol and 30 percent to 35 percent of U.S. bombers are on strip alert.
- Under generated alert rates, roughly 75 percent of on-line SSBNs are on patrol and 60 percent of bombers are on strip alert.
- Nearly 100 percent of the U.S. ICBM force is on alert in both scenarios.

We assume that for a U.S. first strike against Soviet forces:

- Roughly 30 percent of the on-line Soviet SSBN fleet is on patrol and no Soviet bombers are on strip alert under normal peacetime conditions.[1]
- Nearly 60 percent of Soviet SSBNs and 50 percent of Soviet bombers are on alert in the generated alert scenario.
- Approximately 100 percent of the Soviet ICBM force is on alert in both scenarios.

As for the attacker and the number of weapons available for executing the attack, we assume in the first scenario—current forces at normal peacetime alert rates—that the side striking first is able to covertly increase the number of SSBNs at sea and bombers on alert shortly before launching the attack. As a result, U.S. and Soviet alert rates when striking first approach their generated alert rates. The victim's forces remain at peacetime readiness.

In the second scenario—forces at generated alert rates—we assume that after a period of rising tensions between the two superpowers, the alert rates for U.S. and Soviet strategic offensive forces are greatly increased. The actual nature of the attack is little changed from that described for the attack against forces at peacetime alert rates. Not surprisingly, increasing the alert rates for bombers and SSBNs raises the number of weapons that are both available for each side's first strike and capable of surviving the opponent's first strike.

In the first two scenarios, we assume that (1) the attacker simultaneously launches his ICBMs and SLBMs on the adversary's strategic nuclear forces and (2) the Soviets, operating from the Atlantic, the Pacific, and the Gulf of Mexico, are able to conduct short-warning SLBM attacks on U.S. coastal bomber bases, with the following results:

- All SSBNs on patrol survive the initial attack.
- Bombers not on alert and submarines in port are destroyed if they are attacked.
- Alert bombers at U.S. coastal bases are destroyed because the short flight time of SLBMs targeted at U.S. coastal bases from Soviet SSBNs off the U.S. coast does not provide adequate warning for these bombers to escape.

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[1]See Steven M. Meyer, "Soviet Nuclear Operations," *Managing Nuclear Operations*, edited by Ashton B. Carter, John D. Steinbruner, and Charles A. Zraket, The Brookings Institution, Washington, D. C., 1987.

The inclusion of 50 low-observable SLCMs in the U.S. and Soviet arsenals in the third scenario complicates the timing of the attack. We assume that attacking with stealthy SLCMs does not trigger the enemy's tactical warning system until the SLCMs explode on target. Thus, the attacker launches his ICBMs and SLBMs as his SLCMs reach their destinations. Additionally, we assume in the third scenario that:

- Each can locate the other's SSBNs on patrol within a 50-mile radius, leaving U.S. and Soviet SSBNs vulnerable to barrage attack.
- Alert rates are the same as those postulated in the first scenario.
- The Soviets attack U.S. bomber bases with SLCMs, destroying all U.S. bombers on the ground.
- The United States uses its SLCMs to attack Soviet silos.

The United States modernizes its strategic offensive forces in the fourth scenario by substantially increasing their hard-target-kill capabilities. The RVs on the MX ICBM and D-5 (Trident II) SLBM, assumed to have a high probability of destroying hardened Soviet silos, enter the U.S. force structure. Other assumptions are identical to those in the first scenario.

The fifth scenario illustrates a strategic arms accord that reduces weapons and discourages measures that enhance the survivability of U.S. and Soviet forces. We assume that:

- The agreement bans all mobile ICBMs except the road-mobile Soviet SS-25.
- Some 25 percent of the SS-25 force is on alert under normal peacetime conditions in a deployment area of 20,000 square nautical miles. The missiles not on alert remain in a few vulnerable garrisons.
- Soviet SS-24 ICBMs are deployed in existing-type silos at a 100 percent alert rate.
- Other alert rates are the same as those assumed in the first scenario.

The final scenario postulates an agreement that reduces arms and encourages unilateral survivability measures. In this case, we assume that:

- The agreement allows mobile ICBMs.
- The peacetime alert rate of the SS-25 is 50 percent.
- The SS-24 is mounted on rail-mobile launchers with a 100 percent peacetime alert rate and deployed in an area equivalent to 20,000 square nautical miles.
- The U.S. small ICBM is mounted on hardened, road-mobile launchers with a 100 percent peacetime alert rate and deployed in an area of 10,000 square nautical miles.
- Fixed silos are super-hardened.
- Other peacetime alert rates in this scenario approach the generated alert rates assumed in the second scenario.